Attachment 5: Work Plan

The following attachment outlines the proposed scope of work for the South Westside Basin Shallow Groundwater Study, as described in Attachment 4, Project Description. This Work Plan documents all necessary details to show the process by which the City of San Bruno will successfully implement the project and achieve its goals and objectives. This attachment is consistent with and supports Attachments 6 and 7, the Budget and Schedule, respectively.

The Work Plan for the proposed project is provided with work items at a Task and Subtask level consistent with the budget and schedule. Additional information is provided in the Work Plan Summary.

5.1 Work Plan Summary

5.1.1 Scope of the proposed project

Details of the scope of the South Westside Basin Shallow Groundwater Study are provided in the Work Plan, below. In summary, the proposed project improves the overall technical understanding of the shallow groundwater system in the South Westside Groundwater Basin. This includes improvements in the understanding of recharge to the water table, deeper aquifer system, and improved understanding of the nitrate sources in the shallow and deep aquifer system. The project includes the following six major technical areas:

- Defining lithology of the upper subsurface
- Collecting, analyzing, and mapping groundwater elevation data
- Assessing groundwater quality using existing and supplemental data collected as part of this study
- Collecting, sampling, and analyzing stable isotope data
- Performing age dating
- Estimating groundwater recharge and modeling groundwater transport

Together, these technical analyses will lead to an improved understanding of water table conditions, the shallow groundwater system, and the relationships between recharge and deep water supply aquifer quantity and quality. With this information, San Bruno will be better able to develop recharge projects, including low impact development techniques; guide future land use and water use decisions; more reliably model and analyze groundwater conditions; and address nitrate and other water quality concerns in the basin.

Lithology of the upper subsurface will be defined primarily by analyzing available boring logs from the State Water Resources Control Board's GeoTracker database. The boring log data will be

standardized into “coarse grained” or “fine grained” materials and the percent coarse will be defined in 10-foot intervals, or in intervals defined by the nature of the materials or screen intervals. This information will be displayed in maps of the 10-foot intervals from the ground surface to below the water table elevations, or in intervals defined by the nature of the materials or screen intervals. Five cross sections will also be developed. These maps and cross sections will show where fine-grained materials are more prevalent and more likely impede percolating recharge resulting in potential perched aquifers or the loss of recharged water as discharge to adjacent surface water bodies.

Groundwater elevation data will be obtained primarily though available data from the GeoTracker database. The screened interval and groundwater elevation at the wells will be mapped to show the nature and extent of the water table and shallow groundwater system. Elevations of groundwater in wells screened at deeper intervals will also be analyzed to determine the hydraulic connectivitiy between shallow and deeper aquifer zones as assess the potential for perched groundwater .

Groundwater quality data will focus on major anions and cations to distinguish between different water types and on nitrates to define nitrate distribution in the shallow and deep zones. The analysis will include development of piper diagrams, maps and cross-sections of nitrate concentrations, stiff diagrams, and geochemical analysis to assess quality differences and the evolution of observed water types. The results will provide information on where nitrate concentrations are highest, where groundwaters are connected, and where they show distinct waters. Data will come from the GeoTracker database, City of San Bruno and SFPUC records, basin annual monitoring reports, and water quality databases of the California Department of Public Health.

Limited existing stable isotope data will be supplemented with samples collected as part of the project to distinguish water sources and nitrate sources in groundwater. Samples will be collected from the South Westside Basin’s nested multilevel monitoring well sites, which provide depth-discrete samples from short-screened wells at multiple depths. The well nests include seven sites maintained by the SFPUC, two sites maintained by San Bruno, and one site maintained by Daly City (10 sites having a total of 34 individual wells that can be sampled). The oxygen-18 and deuterium results can distinguish between the relative proportions of local low-elevation rainfall and the municipal water supply water comprised of high-elevation imported Hetch Hetchy water and deep groundwater extracted by supply wells. Using our understanding of the areas served with Hetch Hetchy water and irrigated with groundwater we can utilize the isotopic data to calculate the relative proportions of recharge source waters represented by shallow groundwater samples and improve basin recharge estimates.

Nitrogen-15 and oxygen-18 in nitrate will be utilized to estimate nitrogen sources and the extent of denitrification in the basin. Potential major nitrogen sources in the South Westside Basin include historical cattle and dairy operations, natural peat soils, landscape fertilization, and leaking sewer lines. The nitrate and stable nitrogen isotopes data will be integrated with simulated groundwater pathlines and well capture zone analyses provided by the existing Westside Basin Groundwater Flow Model. Reverse-particle tracking shall be employed to identify likely recharge locations for the water extracted by different wells, and comparisons between simulated well capture zones, observed nitrate concentrations (e.g., Daly City’s A Street Well), and identified nitrogen sources used to assess historical and present-day land uses that are impacting groundwater quality.

Age dating will be used to identify recently recharged groundwater in the basin and confirm groundwater velocities simulated by the groundwater flow model. Focused sampling for tritium, helium-3, and noble gases for high-precision age-dating will provide the apparent age of groundwater at variable depths (the apparent age is the length of time since the recharge water was intercepted at the water table). Younger or more modern groundwater indicates more recent recharge and higher

percolation velocities to the sampling depths. The depth distribution of apparent age provides insight into apparent recharge rates. Furthermore, comparisons between observed groundwater ages and velocities with simulated pathlines and travel times will be utilized to confirm modeled hydraulic conductivities, effective porosities, and simulated well capture zones.

All work will be supported by a public outreach task that includes informing the Groundwater Task Force, a stakeholder group developed through the South Westside Basin Groundwater Management Plan.

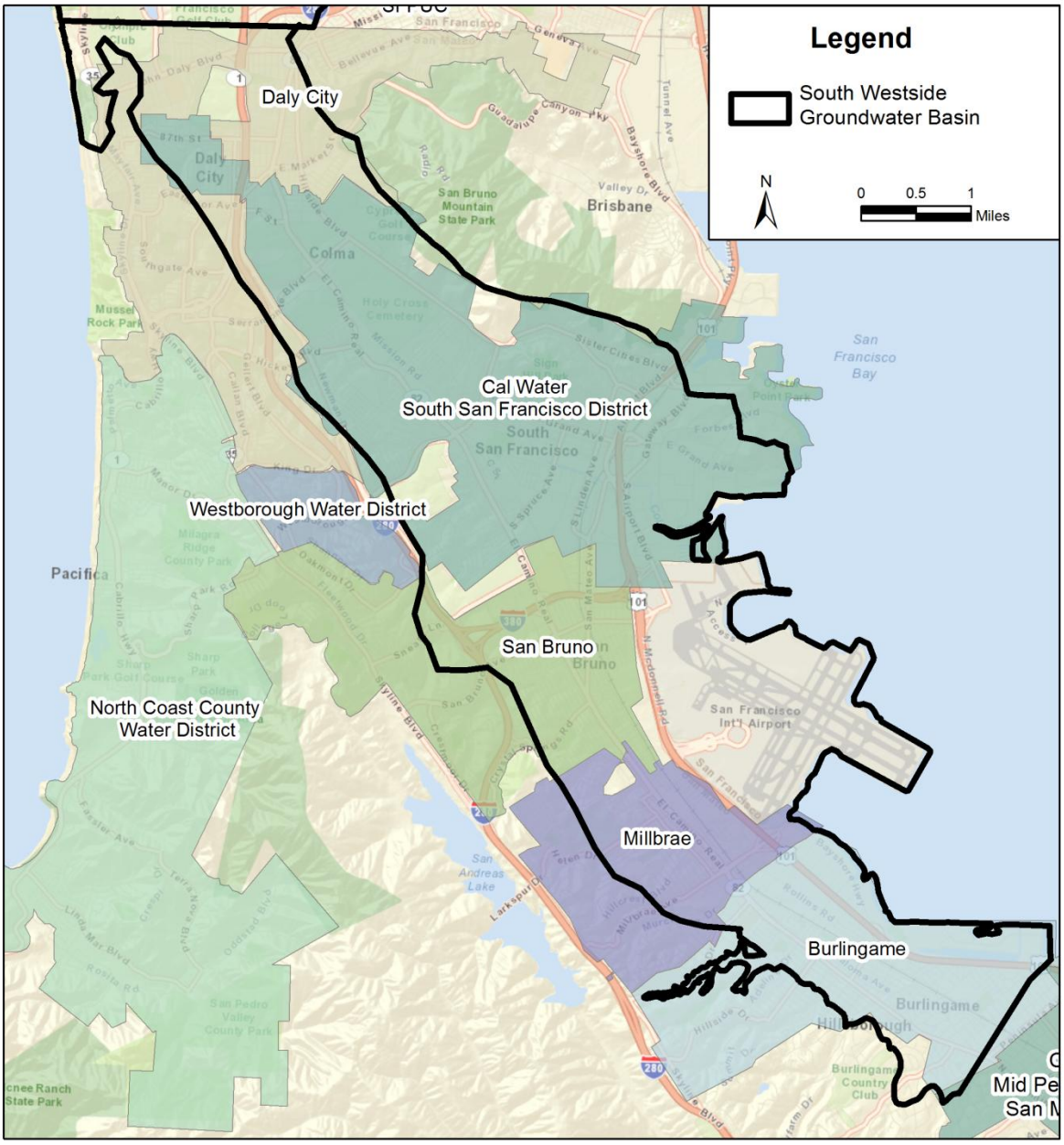


Figure5-1. Area of Proposed Project (South Westside Basin) and Water Agency Service Areas

5.1.2 Purpose, Goals, and Objectives of the Proposed Project Related to Improving Groundwater Management

The South Westside Groundwater Basin faces three primary challenges: groundwater production near the yield of the basin, upward trends in nitrate concentrations and current levels in some wells that exceed maximum contaminant levels (MCLs), and the documented potential seawater intrusion. The proposed South Westside Basin Shallow Groundwater Study will help San Bruno address these challenges by providing improved data and information to better manage the basin. There are two goals for the proposed project:

- To improve the understanding of recharge to support improved water budget estimates, increase the reliability of the existing basin model, and improve decision making with regards to land use decisions, basin operations, and recharge projects.
- To improve the understanding of nitrogen sources impacting water-supply wells, and develop management activities to control the quality of groundwater pumped, manage nitrogen loads, or remove nitrogen impacted groundwater from the aquifer for non-potable use.

The first goal of the proposed project is to improve the understanding of recharge to support improved water budget estimates, increase the reliability of the existing basin model, and improve decision making with regards to land use decisions, basin operations, and recharge projects. The depositional environment of the South Westside Basin was of a lower energy in the southeast and higher energy in the northwest. This difference influences the distribution of basin recharge because the upper subsurface in the southeast is comprised of finer grained materials relative to coarser grained materials found in the northwest. Both conditions present unique issues for groundwater management. In the southeastern portion of the basin, near San Bruno, finer grained materials slow the recharge of water from the surface to the deeper aquifer. However, it is not well understood how much of the water is recharged from the surface compared to water that is recharged in the foothills and then enters the basin from the southwest. Also, the nature of the fine grained sediments that have inhibited seawater intrusion into the basin are not well understood. In contrast, northern portions of the basin are characterized by large turf areas for golf courses, cemeteries, and country clubs. These areas have greater percolation rates, but are also more susceptible to high nitrogen loads in percolating irrigation water. This study will better quantify these spatial variations and improve recharge estimates and factors affecting water quality in the basin.

The second goal of the proposed project is to improve the understanding of nitrogen sources impacting water-supply wells, and develop management activities to control the quality of groundwater pumped, manage nitrogen loads, or remove nitrogen impacted groundwater from the aquifer for non-potable use. Some wells in the northwestern portion of the basin, in the Daly City and South San Francisco areas, have measured nitrate concentrations above MCLs. The source of the nitrogen is not well understood. It is speculated that present-day nitrate concentrations are legacy effects from historical cattle and dairy operations that occurred during the 1880s and early 1900s. Other likely contributors are the natural peat deposits in the aquifer materials, on-going landscape fertilization for cemeteries, golf courses, and open spaces, or historical septic systems and leaking sewer pipes. The data collection, compilation, and analysis provided by this study will help delineate between these potential sources, help project future water quality impacts, and direct activities designed to manage and control future nitrogen concentrations in the aquifer.

Agencies in the South Westside Basin are working to improve recharge in the basin to improve groundwater supply sustainability. For example, basin stakeholders are investigating options for an in-lieu recharge project that utilizes imported surface water to increase basin storage during wet years and places greater reliance on groundwater during dry years. During dry periods, this conjunctive use

operation can make available reduced surface water supplies for other out-of-basin water customers in the South San Francisco Bay Area. The information on the water table, shallow groundwater conditions, and hydraulic interaction between the water table and deeper water supply aquifer provided by this project will help quantify the expected efficiency of an in-lieu recharge approach. Additionally, the City of San Bruno includes the San Mateo Countywide Sustainable Buildings Checklist as part of its application to the Planning Commission. This checklist includes maximizing onsite storm water management through landscaping and permeable pavement as well as rainwater harvesting. Making an informed choice on the benefit to the aquifer of onsite storm water management versus rainwater harvesting will depend on understanding the ability for water to recharge the aquifer as opposed to flowing horizontally to drainage canals and surface water bodies. The proposed project is designed to provide the information needed for decision makers to apply technically sound decisions on where recharge activities can provide benefits to the groundwater system.

The South Westside Basin has significant opportunities for non-potable water use that could be options for high-nitrate groundwater. Most of the basin's numerous cemeteries and golf courses have large turf areas and use groundwater for their irrigation needs. A better understanding of the sources and nature of nitrate in the subsurface can help in the decision process when dealing with high nitrate levels in municipal wells. For example, Daly City's A Street Well has nitrate concentrations exceeding the MCL. Daly City is considering work on the well to blank off the upper screened intervals in an attempt to improve water quality from the well. However, a better understanding of nitrates in the basin could lead to a different tact of piping the high nitrate water to cemeteries within ½ mile of the well for non-potable use, thereby reducing the nitrate load to the aquifer from fertilizer use while continuing to provide the necessary nutrients to irrigated turf. Such a pipeline could eventually become part of a non-potable pipeline for a regional recycled water project that provides tertiary-treated water for irrigation.

5.1.3 Purpose, Goals, and Objectives of the Proposed Project Related to Implementing the SWBGMP

The goals of the proposed South Westside Basin Shallow Groundwater Study are consistent with and support the goals and objectives of the South Westside Basin Groundwater Management Plan (SWBGMP). The goal of the SWBGMP is:

> *To ensure a sustainable, high-quality, reliable water supply at a fair price for beneficial uses achieved through local groundwater management.*

This goal is supported by five Basin Management Objectives (BMOs):

> *1) Maintain Acceptable Groundwater Levels*
> *2) Maintain or Improve Groundwater Quality*
> *3) Limit the Impact of Point Source Contamination*
> *4) Explore Need for Land Subsidence Monitoring*
> *5) Manage the Interaction of Surface Water and Groundwater for the Benefit of Groundwater and Surface Water Quantity and Quality*

The improved understanding of shallow groundwater obtained through this proposed project will address BMOs 1, 2, 3, and 5, which in turn will help address the overall goal of the SWBGMP.

Meeting BMO 1, Maintain Acceptable Groundwater Levels, is largely dependent on the balance of recharge and groundwater production. By improving the understanding of recharge conditions, management efforts can focus on recharge projects providing the highest benefit to the basin, thereby increasing the volume of water that can be sustainably used for beneficial uses. Land use and basin operation decisions also will be improved through the understanding of recharge conditions.

The proposed project will address BMO 2, Maintain or Improve Groundwater Quality, through an improved understanding of nitrate sources. By better defining the source of nitrates, management efforts can focus on sources (if sources are modern) and/or on managing nitrates already in the basin.

Characterizing the shallow groundwater system and assessing the extent of shallow clays and potential existence of perched water will assist in meeting BMO 2 and 3. The proposed project will provide refined information on the clays that act as a partial barrier to seawater intrusion, protecting water quality. More regionally, the improved understanding of the clays will be beneficial for the analysis of point source contamination sites that may be relying on natural clays to prevent downward migration of contaminants to the drinking water aquifer.

The understanding of the shallow groundwater will also assist in meeting BMO 5. Surface water courses in the South Westside Basin are typically small. The largest is Colma Creek, which is concrete lined for most of the lower reaches. Results from this project can be used to determine if removing some of the lining would allow for recharge and thus benefit the groundwater basin, or if the clays would greatly inhibit any additional recharge. Also, the study results can be used to identify areas where recharge basins could be built to enhance recharge. Typically, these would be basins needed to meet flood control needs to justify land costs in the area.

5.1.4 Strategy for evaluating progress and performance at each step of the proposed project.

Progress and performance of the proposed project at each step will be evaluated though deliverables, meetings with the Groundwater Task Force, quarterly and final reports to DWR, and monthly progress reports from the consultant to San Bruno. Deliverables are included in the Work Plan to show completion of steps of the project. These deliverables include:

- Publically accessible website
- Spreadsheets of well data and maps of well locations
- Tables summarizing collected existing water quality data
- Laboratory reports and tables summarizing results
- Maps and tables from Shallow Well Data Analysis
    - Map of wells showing total depth
    - Map of wells showing shallow groundwater elevation
    - Map of deeper groundwater elevation
    - Map of wells showing percent coarse in the upper 10 feet, and in 10-foot intervals down to below the water table elevation, or in intervals defined by the nature of the materials or screen intervals
    - Up to five cross sections showing the percent coarse in the upper portion of the subsurface
    - Map of wells showing the percent clay in the upper portion of the subsurface
    - Map of groundwater elevations below the perched aquifer

    - Table of wells with location, screened interval, water levels, and percent coarse by interval
    - Table of wells with analytical results
    - Chart of delta oxygen-18 and delta nitrogen-15
    - Maps of wells with analytical results
- Report describing the methodology and results and providing conclusions on the conceptual understanding of recharge in the South Westside Basin
    - Draft report, delivered to San Bruno for review
    - Revised draft report, incorporating San Bruno comments, delivered to the Groundwater Task Force, stakeholders, and DWR for review
    - Final report, incorporating all comments received
- Monthly progress reports to San Bruno.
- Quarterly Reports and Final Report to DWR.

The meetings with the Groundwater Task Force will show the progress of the project at four key phases and will allow for the assessment of performance through the quality and quantity of information shared at those meetings. The quarterly and final reports to DWR, and monthly progress reports from the consultant to San Bruno will provide detailed information on the progress at the task level to indicate progress and performance at each reporting interval.

5.1.5 Project Deliverables

As noted above, the tasks include deliverables to allow for assessing progress and accomplishments.

5.1.6 Property Access

No access to private property is required as part of this proposed project. Property access is limited to sampling of wells which are owned by the South Westside Basin water purveyors who have expressed availability of these facilities for sampling.

5.1.7 CEQA and permitting

As a project involving only feasibility or planning studies for possible future actions which San Bruno and other basin agencies, boards, or commissions have not approved, the proposed project is considered exempt from CEQA (CEQA Statutes Section 21102). No permits are anticipated for successful project completion.

5.2 Detailed Work Plan

The following detailed work plan contains work items to be performed under each task of the proposed tasks, consistent with the budget and schedule.

Task 1: Public Outreach

Public outreach is important to the success of the proposed South Westside Basin Shallow Groundwater Study. Proper outreach will result in improved buy-in from potentially affected stakeholders. In the South Westside Basin, this particularly applies to four classes of stakeholders: water purveyors, private groundwater users (cemeteries and golf courses), land use agencies, and environmental interests, notably Lake Merced. These stakeholders have been engaged in the Groundwater Management Plan process, out of which came a Groundwater Task Force for the South Westside Basin. The Groundwater Task Force includes the major stakeholders and working with this established group is the best method of public outreach.

Subtask 1.1: Groundwater Task Force Meetings
Presentations will be made at four meetings of the Groundwater Task Force. These meetings will include:

- An initial meeting to describe the project and to provide an opportunity for input from the Groundwater Task Force and from the public. This meeting is scheduled for June 4, 2013.
- A second meeting to discuss progress on the project, including the shallow well water level and lithology data collection. This meeting is scheduled for November 5, 2013.
- A third meeting to provide an update on project progress, including shallow well data analysis. This meeting is scheduled for September 2, 2014
- A fourth meeting to present the final results. This meeting is scheduled for November 4, 2014.

The presentation materials will be posted on the project website (see subtask 1.3) following the presentation for easy access to stakeholder that could not attend the meetings.

Subtask 1.2: Individual Outreach
It is anticipated that there will be interest in the project from agencies, potentially responsible parties at regional contaminated sites, regulators, and other stakeholders in the basin. The Individual Outreach subtask allows for additional coordination and communication with these stakeholders to address their questions, concerns, or needs.

Subtask 1.3: Website Design and Maintenance
A public website will be developed and maintained to inform stakeholders on the project and keep stakeholders up-to-date on meetings and deliverables. The website will contain a description of the project, dates of meetings, and contact information should additional information be desired. The website will be updated throughout the project with meeting dates, presentation materials, and draft and final technical memoranda. A link to the website will be provided from the City of San Bruno website.

Task 1 Deliverable

- Publically accessible website

Task 2: Shallow Well Water Level and Lithology Data Collection

Shallow well data (defined as wells tapping the water table aquifer) will be collected from existing records held by agencies in the South Westside Basin including nested monitoring well data from the San Francisco Public Utilities Commission (SFPUC) and from the State Water Resources Control Board's GeoTracker database. Spreadsheets of well data and maps of well locations will be developed. Data collected will include identification of wells, well construction, historical groundwater elevation, and lithology. GeoTracker contains approximately 500 sites within the South Westside Basin (see Figure 5-2). Many sites have multiple wells. All available groundwater elevation data associated with wells with x,y data will be utilized, however, analysis of lithologic information will be limited to no more than 200 wells selected to provide the best possible geographic and depth coverage. Geographic coverage will be maximized by overlaying a grid, based on the Westside Basin Groundwater Flow Model grid, on the basin and attempting to include wells that are evenly distributed across that grid, to the extent possible. If significant data gaps are identified, Well Completion Reports from the Department of Water Resources may be consulted to provide additional data in those areas.

Task 2 Deliverables

- Spreadsheets of well data and maps of well locations

Task 3: Shallow Well Water Quality Data Collection and Field Study

The information collected under Task 2 will be supplemented by existing groundwater quality data and a field study to collect additional water quality data. These data will assist in defining the spatial and vertical variations in groundwater quality and the relationship to recharge rates and sources.

Subtask 3.1: Water Quality Data Collection

Existing shallow groundwater quality data will be collected from the GeoTracker database, the California Department of Public Health water quality database, and previous studies available in-house at San Bruno. The water quality data include general chemistry using anion and cation concentrations to distinguish different waters, stable isotopes to distinguish the source of recharge and sources of nitrogen, and age dating to estimate the age of the groundwater. Existing data collected will include anions, cations, oxygen-18, deuterium, nitrogen-15, carbon-13, carbon-14, tritium, and helium-3. Water quality data from GeoTracker will be limited to the same 200 wells identified for lithology in Task 2.

Data on deep groundwater will be obtained from dedicated monitoring wells and production wells routinely sampled by the South Westside Basin agencies and/or from the California Department of Public Health database to provide points of comparison with the shallow groundwater quality data.

All collected data will be inputted into spreadsheet tables.

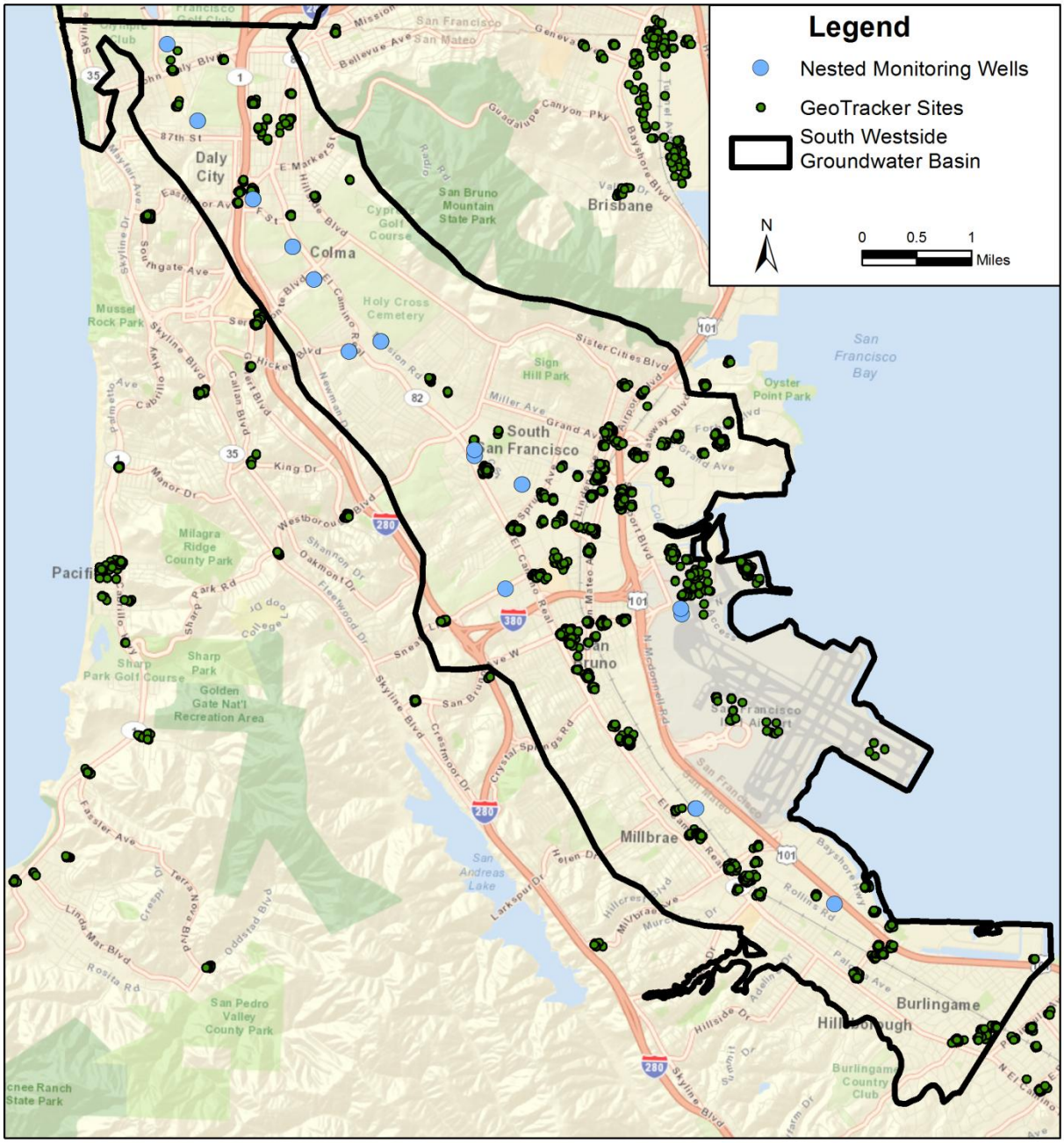


Figure 5-2. Location of GeoTracker Sites and Nested Monitoring Wells in the South Westside Basin

Subtask 3.2: Water Quality Field Study

The field study will obtain new information from the recently installed nested monitoring wells in the South Westside Basin. SFPUC maintains seven nested monitoring wells in the South Westside Basin. Each site typically contains four monitoring wells installed at variable depths and constructed using 10 to 20 foot screened intervals (the deepest wells can have screen lengths up to 70 feet in length). Additionally, two nested monitoring well sites maintained by San Bruno and one site maintained by Daly City will also be considered for sampling. These wells with relatively short screen intervals enable depth distributed water level measurements and water quality sampling. In total, up to 34 wells will be sampled, as listed below. Additionally, oxygen-18 and deuterium sampling will be performed for delivered Hetch Hetchy (every two months for a period of 1 year), local precipitation (two sampling events), and deep groundwater (two samples) to provide information on those end-members for the analysis.

Table 5-1 Wells to be sampled

Cluster	Wells in Cluster
SFPUC Clusters	
CUP-10A	MW160, MW250, MW500
CUP-18	MW230, MW425, MW490, MW660
CUP-19	MW180, MW475, MW600, MW690
CUP-22A	MW140, MW290, MW440, MW545
CUP-23	MW230, MW440, MW515, MW600
CUP-36-1	MW160, MW270, MW455, MW585
CUP-44-1	MW190, MW300, MW460, MW580
San Bruno Clusters	
SFO	S, D
Burlingame	S, M, D
Daly City Wells	
Park Plaza	460, 620

The wells will be sampled for anions, cations, oxygen-18, deuterium, nitrogen-15 in dissolved nitrate, and oxygen-18 in dissolved nitrate. Twelve of the wells will also be sampled for age dating using tritium and helium-3 and helium-4. Sampling will be performed by SFPUC consultants, as an in-kind contribution of SFPUC, tasked with ongoing sampling from the SFPUC nested monitoring wells. Such sampling will follow SFPUC's standard sampling protocols, as described in *Sampling and Testing Protocol for the Westside Basin*. This includes measuring static water levels; purging at

least three casing volumes prior to sampling; and field measurements for dissolved oxygen, temperature, pH, and specific conductance using a flow-through chamber. Sampling will include the collection of field blanks and duplicate samples (approximately ten percent of the total samples).

Containers, temperatures, and hold times will be selected to meet the requirements of the analytical methods. Samples will be analyzed by an accredited laboratory using standard methods, as listed below, or equivalent.

Table 5-2 Analytes and Methods

Analyte	**Method**
Anions	EPA 300.0, SM 2320B
Cations	EPA 200.7 or 6010B
Oxygen-18 and Deuterium	Laser Water Isotope Analyzer V2 at UC Davis SIF
Nitrogen-15 and oxygen-18 of NO_3	gas concentration system / isotope-ratio mass spectrometer at UC Davis SIF
Tritium	Helium ingrowth at Hydrotrace
Helium-3, Helium-4	Copper tube method at Hydrotrace

Task 3 Deliverables

- Tables summarizing collected existing water quality data
- Laboratory reports and tables summarizing results

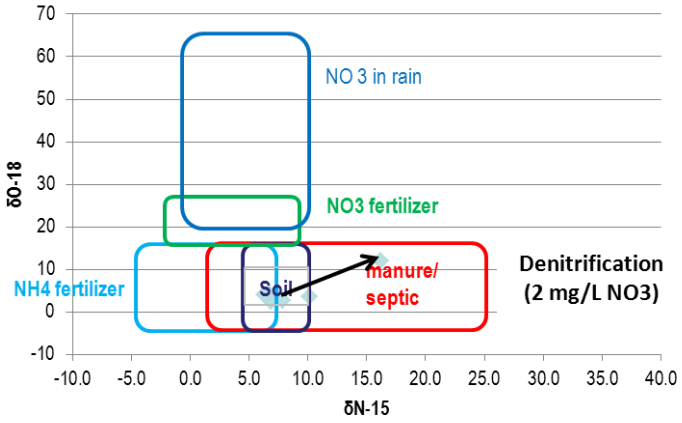
Task 4: Shallow Well Data Analysis

The collected data will be analyzed to develop information on water table conditions and the potentially perched water bearing zone to improve the estimated quantity and distribution of water table recharge in the basin.

Groundwater elevation data will be analyzed together with screened-interval and/or total depth information to map the water table and assess vertical gradients between the shallowest water-bearing zone and deeper groundwater.

Lithology analysis of the boring logs will provide information on the extent and thickness of shallow fine-grained units as the thickness and extent of these units are responsible for development of perched water bearing zones and the retardation of seawater intrusion. Shallow wells are typically drilled for environmental investigations and their boring logs tend to be more accurate than those for deeper wells, due to both the intent of the drilling as well as the selection of drilling and sample collection methods. The boring logs will be classified into a discrete binary texture classification of either "coarse grained" or "fine-grained" intervals, following the methodology utilized by the US Geological Survey (USGS) for the development of textural models[1]. In this methodology coarse-grained sediment is defined as consisting of sand, gravel, pebbles, boulders, cobbles, or conglomerate. Fine-grained sediment is defined as consisting principally of clay, lime, loam, mud, or silt. While the USGS study looked at 15-meter intervals, this effort will look at 10-foot intervals, due to the finer scale of this analysis, or in intervals defined by the nature of the materials or screen intervals.

Water chemistry data will provide information on differences between water sources and quality, and depth distribution of hydraulic in different parts of the basin. Stiff diagrams and piper charts will be used to identify different waters within the basin, spatially and with depth. Stiff diagrams and piper charts will be used to identify variations in different water quality types within the basin, spatially and with depth. Stable isotopes of oxygen (oxygen-18) and deuterium (D) will be used to estimate the relative proportions of local rainfall recharge and municipal supply water in shallow groundwater samples; municipal water is a mixture of imported surface water from Hetch-Hetchy reservoir and deep groundwater extracted by wells. The isotopic composition of these end member water sources (rainfall and municipal water, composed of deep groundwater and Hetch Hetchy water) will be characterized and their proportional contributions required to produce the observed isotopic composition measured in shallow groundwater samples will be calculated. The resulting proportions will be compared with the assumed values employed to calculate and model the spatial distribution of groundwater recharge in the basin.



[1] Faunt, C. C., Belitz, K., & Hanson, R. T. (2009). Development of a three-dimensional model of sedimentary texture in valley-fill deposits of Central Valley, California, USA. *Hydrogeology Journal*, 625-649.

Stable isotope ratios of nitrogen-15 and oxygen-18 in dissolved nitrate will be used to reveal likely nitrogen sources and identify denitrification. A plot of delta nitrogen-15 and delta oxygen-18 (δ15N vs. δ 18O) with their characteristic composition in various nitrate sources (rainfall, fertilizers, soil organic matter, and manure/septic) will be developed. Such data will help confirm suspected nitrate sources in the South Westside Basin, including historical cattle and dairy operations, natural peat soils, and landscape fertilization.

The spatial distribution of isotope results with depth and between nested well sites can be compared to the simulated recharge locations from the Westside Basin Groundwater Flow Model to identify potential relationships between current and past land uses and present-day nitrate concentrations in groundwater. Such an understanding can allow for future estimates of changes in groundwater quality as a result of changes in groundwater flow patterns altered by changes in recharge and pumping.

The apparent groundwater age ($Age_{apparent}$) is the time elapsed since the water originally entered the groundwater system as recharge. The tritium-helium age dating technique is based on a helium isotope mass balance that determines the amount of tritiogenic helium-3 ($^3He_{tri}$) derived from the radioactive decay of H. The technique utilizes the contemporaneous ^3H and $^3He_{tri}$ content to estimate the original tritium content of the recharge. Select monitoring wells located along approximate groundwater-flow paths shall be sampled and the age-dating results utilized to estimate groundwater velocities. These velocity estimates will be used to confirm modeled flux rates and advective travel time. Additionally, the apparent ages can be associated with other chemical data like nitrate concentrations to elucidate possible relationships between past and present-day land and water use and the spatial distribution of observed water quality in the basin.

Task 4 Deliverables

The information will be presented in maps and tables, including the following:

- Map of wells showing total depth
- Map of wells showing shallow groundwater elevation
- Map of deeper groundwater elevation
- Map of wells showing percent coarse in the upper 10 feet, and in 10-foot intervals down to below the water table elevation, or in intervals defined by the nature of the materials or screen intervals
- Up to five cross sections showing the percent coarse in the upper portion of the subsurface
- Map of wells showing the percent clay in the upper portion of the subsurface
- Map of groundwater elevations below the perched aquifer
- Table of wells with location, screened interval, water levels, and percent coarse by interval
- Table of wells with analytical results
- Chart of delta oxygen-18 and delta nitrogen-15
- Maps of wells with analytical results

Task 5: Reporting

A report will be prepared describing the methodology and results and providing conclusions on the conceptual understanding of recharge in the South Westside Basin. The conceptual understanding of

recharge will be built upon the analysis of the perched water table, lithology of the materials of the upper subsurface, groundwater quality data, stable isotopes data, age dating, and groundwater modeling. The conceptual understanding will include the nature and extent of the perched aquifer and shallow subsurface conditions and how this understanding can improve groundwater modeling, land use and water use decisions, the ability to site and implement recharge projects including low impact development techniques, and the ability to control nitrate concentrations.

The report will incorporate suggestions on how to use the information to better the basin. This includes refinements to the groundwater model, which is scheduled for recalibration in 2016; potential for nitrate removal from the subsurface through shallow pumping for irrigation purposes; areas for recharge through low impact development techniques; and any additional refinement to the understanding of the potential for seawater intrusion from San Francisco Bay, which is partially controlled by the shallow Bay Muds.

The report will be provided in draft form for review by the City of San Bruno. Comments from the City will be incorporated into a new draft which will be provided to the Groundwater Task Force, California Department of Water Resources (DWR), and other basin stakeholders through existing distribution lists and the project website. Comments will be incorporated into a final report, which will be distributed out to the Groundwater Task Force, DWR, and other basin stakeholders and posted to the project website.

Task 5 Deliverables

- Draft report, delivered to San Bruno for review
- Revised draft report, incorporating San Bruno comments, delivered to the Groundwater Task Force, stakeholders, and DWR for review
- Final report, incorporating all comments received

Task 6: Project Management and Coordination

The project manager will direct the technical activities, subject to the overall direction provided by the Groundwater Task Force, other stakeholders, and DWR. This will encompass overseeing technical direction of the work, reviewing all deliverables, conducting communications with local agencies, scheduling project meetings and conference calls, and managing fiscal administration of the project.

Subtask 6.1: Coordination with San Bruno, DWR, and Other Stakeholders

San Bruno's consultant, RMC, will coordinate with San Bruno, DWR, and other stakeholders to ensure the project purpose is met with full participation. This task also includes California Environmental Quality Act (CEQA) compliance; as a project involving only feasibility or planning studies for possible future actions which San Bruno and other basin agencies, boards, or commissions have not approved, the proposed project is considered exempt from CEQA (CEQA Statutes Section 21102).

Subtask 6.2: Monthly Progress Reports

Monthly progress reports will be developed by RMC and submitted to San Bruno to inform the agency on progress and accomplishments and the status of budget and schedule. These reports

will be used in the preparation of Quarterly Reports to DWR under Subtask 7.2 and will contain:

- Narrative Progress Report addressing the following:
    - Specific accomplishments during the reporting period
    - Problems encountered or anticipated and recommended solutions
    - Accomplishments scheduled for the next reported period
    - Results of any significant activities
    - Specific details concerning activities or issues or problems affecting the project design, scope, budget, or schedule
- A Cost Report for each task showing the following:
    - Current period and cumulative expenditures to date
    - Estimated cost to complete
    - Estimated cost at completion
    - Approved budget
    - A comparison of the estimated cost at completion with the approved budget to show and discuss any variance

Task 6 Deliverables

- Monthly progress reports to San Bruno.

Task 7: Administration

Subtask 7.1: Develop and Administer Contracts

San Bruno will develop and administer contract with DWR through in-kind staff time. No grant funding will be spent on contracts.

Subtask 7.2: Development of Quarterly Reports and Final Report

San Bruno will develop and submit Quarterly Reports and the Final Report to DWR through in-kind staff time. No grant funding will be spent on quarterly reports.

Subtask 7.3: Coordination with DWR

San Bruno will coordination with the DWR project manager on progress and unanticipated activities through in-kind staff time. No grant funding will be spent on coordination with DWR.

Task 7 Deliverable

- Quarterly Reports and Final Report to DWR.